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ARS SPECIAL REPORT

Cattle-Grub Control With Systemic Insecticides

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SUMMARY

Two new systemic insecticides, Dow ET-57 and Bayer 21/199, are being used experimentally by Agricultural Research Service entomologists to fight the cattle grub, a parasite that burrows its way through the skin and tissue of cattle and costs the beef and dairy industries millions of dollars annually.

Tests performed by the Agricultural Research Service and summarized in this report indicate that both of these insecticides kill grubs before they can damage the flesh and hides of cattle. Neither appears to be harmful to cattle when administered at the proper levels. Considerably more data are available on ET-57 than on 21/199, but research with both chemicals is being continued. Neither of these systemic insecticides is being recommended at present as a means of controlling the cattle grub. Both, however, show considerable promise.

Information in this report was provided by the Entomology Research Branch, Agricultural Research Service

CATTLE-GRUB CONTROL WITH SYSTEMIC INSECTICIDES

Agricultural Research Service entomologists have recently demonstrated the effectiveness of two insecticides against the cattle grub--a parasite that costs dairymen and cattlemen millions of dollars annually. Both are systemic in action, moving to all parts of the animal soon after administration. Both destroy the grub in the animal's body before materially damaging the flesh and hide of its bovine host. Neither appears to be toxic to cattle at dosages used in grub-control experiments.

Dow ET-57[1] is an orally administered systemic that is absorbed in the digestive tract and circulates in the body fluids to all parts of the animal, thus destroying the grub. Treatment of animals with ET-57 apparently kills the young grubs before they reach the animal's back, thereby reducing damage to the flesh and hide.

Bayer 21/199[1], also a systemic insecticide, is applied by spraying. The manner in which this insecticide is taken into the animal's body to destroy the grubs has not been determined. However, some of it is absorbed through the animal's skin. If administered after the grub enters the animal's body, the parasite is destroyed. Relatively little information is available on the potential of 21/199, but research results obtained to date are encouraging.

Neither ET-57 nor 21/199 can as yet be recommended as a new cattle-grub control measure, but they show promise. Both have a potential advantage over rotenone, the only insecticide currently being used to control cattle grubs. Rotenone, used as a spray, wash, dip, or dust, kills a large percentage of the grubs once they have reached the animal's back. It is not systemic in its action and only reaches the grubs through the breathing holes these parasites make in the animal's skin. By that time, the flesh and hide are already damaged. Rotenone does reduce the potential fly population by destroying the grubs before they become adult flies. However, to reduce materially grub infestations and heelfly activity with rotenone, several treatments are required each season, and community-wide programs extending over 3 or more years are necessary.

CATTLE-GRUB LOSSES

Cattle grubs and heelflies are responsible for sizeable losses to the American livestock industry. Actual dollar loss figures for the United States cannot be obtained, but these losses have been estimated by industry groups to range between $100 million and $300 million annually.

Hides and meat of infested animals are damaged during the latter part of the larval stage of the grubs, when they encyst in the backs of cattle. A third of the hides of the 18 million cattle slaughtered in the United States in 1948 contained 5 or more holes and were sold at a discount of a cent a pound. In the same year about 14 million pounds of choice meat were trimmed from carcasses to remove damaged areas.

The adult heelflies cause damage particularly at the time of egg-laying, when they greatly excite livestock. Although the flies cause no pain, cattle seem to regard them with fear and apprehension. Tails high, approached animals run about madly, occasionally injuring themselves, but

[1]Mention of this product does not constitute an endorsement by the U. S. Department of Agriculture over other products or a guaranty or warranty of the standard of this product.

more often stand in shade or water for hours at a time. This failure to graze causes loss of flesh, and milk production of dairy animals may drop as much as 25 percent.

THE CATTLE GRUB

The cattle grub is the maggot stage of either the common or the northern heelfly. The common heelfly (Hypoderma lineatum) exists in all parts of the United States, but the northern species (H. bovis) is found principally in the northern half of the country.

Heelflies look like small bumblebees--hairy, black, and striped with yellow. The common species is nearly three times as large as the housefly, while the northern heelfly is somewhat larger then the common species.

Common heelflies appear during the first warm days of spring. They have no mouth parts and do not bite or sting. They live only a few days, but in that time deposit hundreds of eggs on the hair of cattle--usually on the lower legs.

Animal heat causes the eggs to hatch in 3 or 4 days and the extremely small, spiny maggots crawl down the hair and begin to burrow through the skin. Once they penetrate the skin they slowly work their way through the soft connective tissues of the animal's muscles, until they reach the gullet. There they remain for several months before beginning their migration to the animal's back. When the back region is reached, they lodge just below the skin, make breathing holes in the hide, and continue to grow for a period of about 6 weeks. Successive molts take place until the grubs are an inch or more in length. The mature, black, wrinkled-appearing grubs then work their way out of the enlarged breathing holes, fall to the ground, move into soil or trash, and form hard, black pupal cases in which the change from grub to fly takes place. Four to seven weeks later, depending on temperature, the flies emerge, dry their wings, and begin mating. Egglaying may begin the same day the adult females emerge. The entire life cycle covers about a year, 7 to 9 months of which are spent as grubs in the body of the host (see figure 1).

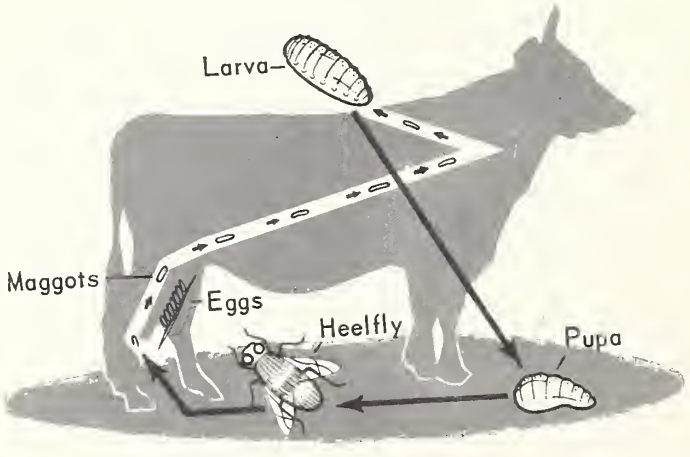

Figure 1.--Life cycle of the common cattle grub. The heelfly lays eggs on the hair of the animal's legs. Small maggots hatch and penetrate the skin, beginning a 7- to 9-month journey through the body that ends in the back. The mature grubs leave the animal, fall to the ground, and form pupae. From these hard black cases the adult heelflies emerge to begin a new cycle.

Northern heelflies appear later in the season than the common species and their activities continue after the common heelfly has disappeared. The life history of the two species is much the same except that the northern species congregate in the spinal canal, instead of the gullet, on their way to the skin of the back. The northern grubs are most abundant after the larvae of the common heelfly have disappeared.

RESEARCH WITH SYSTEMIC GRUB-KILLERS

In 1947 scientists began the search for a chemical that would destroy both species of grubs during their early development in the tissues of an animal. By 1955 several insecticides showed promise when fed to cattle or injected beneath the skin. Aldrin, Bayer L 13/59, Chlorthion, Diazinon, dieldrin, and lindane produced encouraging results. Most of these chemicals killed some of the grubs after they were encysted in the backs of cattle, but none of them destroyed the small larvae in other parts of the body. Consequently, they were no more effective than rotenone. Phenothiazine was reported to show promise as a dual treatment for cattle grubs and stomach worms and was tested extensively by State and Federal workers. These tests indicated that it did not provide adequate grub-control.

Research With ET-57

In 1955, however, ARS tests revealed that a phosphate compound, ET-57 (0,0-dimethyl 0-2,4,5-trichlorophenyl phosphorothioate), killed cattle grubs while the larvae were in the back and also before they entered the region of the back. Given orally at the rate of 100 milligrams per kilogram of animal weight (about 1.6 ounces to a 1,000-pound animal), the chemical showed no evidence of toxic effects on cattle.

Corvallis Test, March 1955

First evidence of the killing power of ET-57 was demonstrated on an infested calf at the Entomology Research Branch Laboratory, Corvallis, Oreg., early in 1955. The high rate of kill that followed administration caused researchers there to set up a test that included 19 calves infested with both species of grubs. The animals were divided into groups, and each group was treated with a different level of ET-57, either injected under the skin or given orally in a capsule. Best results were obtained on the 4 animals dosed orally at the 100-milligram rate. At the time ET-57 was administered, these calves had a total of 75 grubs in their backs, some of which were nearly ready to drop from the cyst. Only 14 survived of which 2 became adult flies.

Kerrville Test, June 1955

As a result of the Corvallis test, ARS scientists at the Entomology Research Branch Laboratory, Kerrville, Tex., decided to administer ET-57 to infested calves before the grubs reached the region of the back.

In June 1955--2 to 3 months before grubs normally appear in the backs of animals raised in that area--5 Hereford calves, infested with the common cattle grub, were treated orally with ET-57 at the 100-milligram rate. Five similar calves from the same herd were treated with another

chemical. The backs of all 10 animals were regularly checked for grub appearance during August, September, October, and November. During the entire period, a total of only 4 grubs appeared on the backs of the ET-57 treated calves. All 4 died before emerging. A total of 98 grubs appeared in the backs of the calves treated with the second chemical, and most of them completed their growth and emerged from the animals.

Corvallis Test, December 1955

Both the Corvallis and Kerrville tests indicated that ET-57 had definite possibilities, and researchers were anxious to try the chemical on larger numbers of animals. In December they obtained 56 animals, all of which were likely to have grubs, and divided them into 3 groups. Group 1 consisted of Hereford and Angus cattle; group 2 consisted of Herefords only; and group 3 consisted on Holsteins only. Some animals in each group were treated orally at the rate of 50 milligrams of ET-57 per kilogram of animal weight; some were treated orally at the rate of 100 milligrams of ET-57; and the remaining animals were not treated. Grub counts were made regularly during January, February, March, April, and May of 1956.

In all 3 groups the cattle treated at the 100-milligram rate averaged only 1.3 grubs per animal while the untreated animals averaged 22.1 grubs each (table 1). In groups 2 and 3, cattle treated at the 100-milligram rate

Table 1.--Grub infestations in cattle treated with 100 milligrams of ET-57 per kilogram of animal weight, Corvallis, Oreg., December 1955

Item	Animals in test		Average number of grub infestations per animal	
	Treated	Untreated	Treated	Untreated
Group 1.....	7	5	3.5	37.9
Group 2.....	7	6	.0	9.4
Group 3.....	5	5	.0	21.5
Total or average.....	19	16	1.3	22.1

developed no grubs at all, while the untreated animals averaged 9.4 and 21.5 grubs, respectively. All animals treated at the 50-milligram rate developed more grubs than the animals dosed at the 100-milligram rate but fewer grubs than the untreated cattle. It is believed that the chemical would have been even more efficient if administered earlier in the year--before the grubs began their migration to the back region.

Kerrville Test, February 1956

In February 1956, and while the second Corvallis test was being conducted, the Kerrville Laboratory purchased 20 grub-infested steers and 40

infested heifers in South Dakota. These were divided into 3 comparable groups, and on February 10 groups 1 and 2 were treated with ET-57 at the 100-milligram rate. The animals were then trucked to Kerrville, Tex., where, on February 17, they were clipped and the number of grubs in the back of each animal counted. The untreated animals had nearly twice as many grubs present as the treated animals (table 2). However, a week had elapsed since ET-57 was administered and it is assumed that at least part of the difference reflected the effects of the insecticide.

Table 2.--Grub infestations in cattle treated on February 10, 1956, with 100 milligrams of ET-57 per kilogram of animal weight, Kerrville, Tex.

Item	Average number of grub infestations per animal	
	Treated[1]	Untreated[2]
Found on backs, February 17, 1956.....	17.7	31.2
Additional grubs appearing between February 17 and June 10, 1956.....	.0	34.0
Total grubs counted, February 17 - June 10, 1956..	17.7	65.2
Grubs that survived and left the host.....	1.6	57.9

[1] Number of treated animals, 35.
[2] Number of untreated animals, 25.

After February 17 when the first count was made, not a single grub appeared in the backs of the treated animals, but an average of 34 new grubs appeared in the backs of the untreated animals. Since no new grubs appeared in the treated animals, there was no additional hide damage. It is probable that all hide damage would have been avoided if the chemical had been administered soon enough.

The insecticide was also effective in killing grubs already encysted in the animals' backs. An average of only 1.6 out of 17.7 grubs survived in treated animals, compared with an average of 57.9 out of 65.2 in untreated animals. A comparison of grub-survival in treated and untreated animals indicates that grub mortality in treated animals was 97.2 percent greater than in untreated animals.

Spray Tests

A limited number of tests were made at Corvallis in which ET-57 was administered by spraying. The spray killed only those grubs already encysted in the animals' backs and consequently was not as effective in preventing damage as orally administered treatments.

Toxicity Test

In none of these tests was there any indication that ET-57, administered orally at the 100-milligram rate, affected the health of the animals or their

meat production, but specific toxicity levels were not determined. A separate toxicity test was run at Kerrville, Tex., however, and a number of chemicals, in varying amounts, were administered to livestock. A compound was classified as toxic when it caused any deviation from the animal's normal action or behavior that was observable with the human eye. ET-57 was found to be nontoxic at the 100-milligram rate. At 150 milligrams per kilogram of animal weight, it was considered toxic, but the animal recovered quickly from the effects of the chemical. Despite these results, ET-57 will not be recommended for use by stockmen until more complete toxicological information is available.

Residue Tests

Although ET-57 at the 100-milligram rate did not prove toxic to cattle, no information was available on residues of the insecticide in the meat of dosed animals. Researchers ate meat from slaughtered experimental animals without suffering ill effects, but again no specific test was conducted to determine whether residues existed and, if so, to what extent they might be toxic, or how long they remained.

In separate experiments at Kerrville and at Corvallis, calves were dosed with ET-57 containing a radioactive tracer called P-32. The Kerrville calf was slaughtered 3 days after treatment, and the fat was found to contain 50 parts per million of unchanged ET-57. The Corvallis calf was slaughtered 14 days after treatment and the fat was found to contain only 7 parts per million, or a trace amount of the chemical. This rapid decrease suggests that the chemical leaves the body rapidly. No data are available on the length of time that should elapse before the milk of treated animals is free of the insecticide, but it is advisable that producing dairy cows not be employed in experimental work unless the milk is to be destroyed. No recommendations or suggestions can be made for anything but experimental use until additional information on residues is obtained.

Taste Tests

Researchers also attempted to determine whether the chemical affected the flavor of the meat. Taste tests were conducted by the Oregon Agricultural Experiment Station. To provide meat for these tests, 4 yearling Herefords of the same weight and from the same herd were selected. Two of the animals were treated by ARS scientists with ET-57 at the 100-milligram rate, and all 4 were slaughtered 10 days later. The carcasses were cooled and aged for 3 days under the same conditions.

A taste panel made 4 replicate flavor-difference tests on various cuts from these carcasses. Panel members were unable to detect any difference of flavor in rib roasts, round steaks, liver, or pot roasts from the four carcasses. No difference was noted in the sirloin steaks that were cooked for 60 minutes. Flavor differences were noted in sirloin steaks cooked either 15 or 30 minutes, but the difference in flavor between the two untreated carcasses was as great as between the treated and untreated carcasses. Therefore, it was concluded that this flavor difference could not be attributed to the insecticide treatment. ARS Human Nutrition Research Branch reported similar results. Results of flavor-difference tests by the Texas Agricultural Experiment Station did not fully coincide with those mentioned above, but there is no conclusive data to show that ET-57 affects meat flavor.

Summary

The results of these tests should not be construed as proving that a new method of controlling the cattle grub has been found. They indicate only that ET-57 shows promise as a systemic grub-killer.

The tests do indicate that ET-57, administered orally at the 100-milligram rate shortly after the grub has entered the body, will kill 82 to 100 percent of infested grubs before they can damage the flesh or hide. In addition, they indicate that the health of the animal is not affected at the 100-milligram rate.

Research With Bayer 21/199

Research with Bayer 21/199 has been under way for a relatively short time, but it also shows promise as a cattle-grub killer. Tests have shown that 21/199, like ET-57, is a systemic insecticide capable of destroying larvae before they can damage the flesh and hides of their hosts. Unlike ET-57, it destroys grubs when applied as a spray, a method which would be more practical for the treatment of range cattle than oral administration.

FURTHER RESEARCH

Research, by Federal and State workers, is continuing with both chemicals. Additional tests are being run on sizeable numbers of animals to determine the kill of grubs when cattle are dosed shortly after the maggots enter the body. Results of these tests should be available by the spring of 1957.

Additional research is needed on toxicity to treated animals and on toxic residues in meat and milk. Manufacturers of both chemicals are obtaining data on toxicity and residues which is required before clearance can be granted by the Food and Drug Administration to release the chemicals into commercial channels.

Researchers are interested in learning more about the action of the chemicals in the tissues. They do not know how the insecticides kill grubs, where in the animal's body the grubs are killed, or at what age grubs are most susceptible to the action of the insecticides. Mode-of-action studies may provide answers to these and other questions.

More information is also needed on methods of administration. ET-57 has been sprayed on the skin and injected under the skin, but it seems to be more effective when given orally as a drench, in a capsule, or as a bolus. The last-mentioned form appears to be the most practical of the oral methods. The bolus is a large pill, and it is propelled down the animal's throat with a balling gun. The bolus seems to disintegrate shortly after reaching the first stomach and is not regurgitated. Although data obtained to date indicate that oral administration of the bolus is preferable to other methods of administration, additional research may reveal a more practical or effective method.

Bayer 21/199 has been successfully administered as a spray, but it may also be effective when swabbed on a limited area of the skin, or when applied in some other manner. Tests now under way may indicate which is the best method.

At the present time there is no way of knowing how much time will elapse before ET-57, 21/199, or some other chemical can be recommended as an effective and practical means of controlling cattle grubs. ARS scientists are continuing research, confident that increasing knowledge of systemic insecticides will make a major contribution to the Department's effort to reduce the $100 million to $300 million annual losses caused by cattle grubs.

Agriculture - Washington